Significant Figure Rules

There are three rules on determining how many significant figures are in a number:

1. Non-zero digits are always significant.
2. Any zeros between two significant digits are significant.
3. A final zero or trailing zeros in the decimal portion ONLY are significant.

Focus on these rules and learn them well. They will be used extensively throughout the remainder of this course. You would be advised to do as many problems as needed to nail the concept of significant figures down tight and then do some more, just to be sure.

Please remember that, in science, all numbers are based upon measurements (except for a very few that are defined). Since all measurements are uncertain, we must only use those numbers that are meaningful. A common ruler cannot measure something to be 22.4072643 cm long. Not all of the digits have meaning (significance) and, therefore, should not be written down. In science, only the numbers that have significance (derived from measurement) are written.

Rule 1: Non-zero digits are always significant.

If you measure something and the device you use (ruler, thermometer, balance, etc.) gives you a number, then you have made a measurement which gives significance to that particular numeral (or digit) in the overall value you obtain. A number like 26.38 would have four significant figures and 7.94 would have three. The problem comes with numbers like 0.00980 or 28.09.

Rule 2: Any zeros between two significant digits are significant.

Rule 3: A final zero or trailing zeros in the decimal portion ONLY are significant.

This rule causes the most difficulty with students. Here are two examples of this rule with the zeros this rule affects in boldface:

0.005**00** 0.0304**0** 2.3**0** x 10^{-5} 4.5**00** x 10^{12}

What Zeros are Not Discussed Above

Zero Type #1: Space holding zeros on numbers less than one.

The digits that are NOT significant in boldface: **0.00**500 **0.0**3040

These zeros serve only as space holders. They are there to put the decimal point in its correct location and DO NOT involve measurement decisions. Upon writing the numbers in scientific notation (5.00 x 10^{-3} and 3.040 x 10^{-2}), non-significant zeros disappear.

Zero Type #2: the zero to the left of the decimal point on numbers less than one.

When a number like 0.00500 is written, the very first zero (to the left of the decimal point) is put there by convention. Its sole function is to communicate unambiguously that the decimal point is a decimal point. If the number were written like this, .00500, there is a possibility that the decimal point might be mistaken for a period. Many students omit that zero. They should not.

Zero Type #3: trailing zeros in a whole number.

200 is considered to have only ONE significant figure while 25,000 has two.

If 200 has two significant figures, then 2.0×10^2 is used. If it has three, then 2.00×10^2 is used. If it had four, then 200.0 is sufficient. See rule #2 above.

How will you know how many significant figures are in a number like 200? In a problem like below, divorced of all scientific context, you will be told. If you were doing an experiment, the context of the experiment and its measuring devices would tell you how many significant figures to report to people who read the report of your work.

Zero Type #4: leading zeros in a whole number.

00250 has two significant figures. 005.00×10^{-4} has three.

Exact Numbers

Exact numbers, such as the number of people in a room, have an infinite number of significant figures. Exact numbers are counting up how many of something are present, they are not measurements made with instruments. Another example of this are defined numbers, such as 1 foot = 12 inches. There are exactly 12 inches in one foot. Therefore, if a number is exact, it DOES NOT affect the accuracy of a calculation nor the precision of the expression. Some more examples:

There are 100 years in a century.

2 molecules of hydrogen react with 1 molecule of oxygen to form 2 molecules of water.

There are 500 sheets of paper in one ream.

Interestingly, the speed of light is now a defined quantity. By definition, the value is 299,792,458 meters per second.

Practice Problems

Identify the number of significant figures:

1)____ 3.0800	2)____ 0.00418	3)____ 7.09×10^{-5}
4)____ 91,600	5)____ 0.003005	6)____ 3.200×10^9
7)____ 250	8)____ 780,000,000	9)____ 0.0101
10)____ 0.00800	11)____ 6,000,000	12)____ 4.2×10^{-4}